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LCP Delta Insights: Review of Electricity Market Arrangements

Including a deep dive on "Impacts of Locational Pricing"

MARCH 2024

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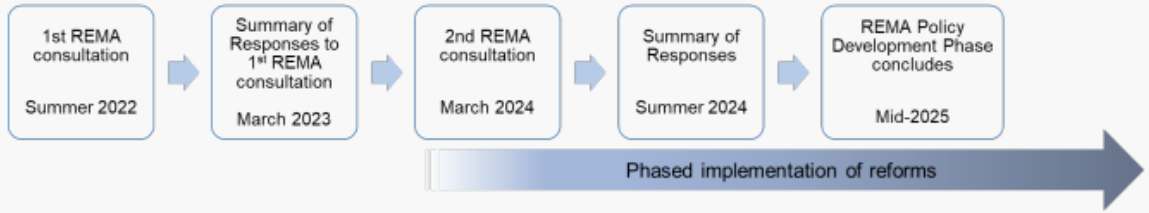
Review of Electricity Market Arrangements

What is REMA?

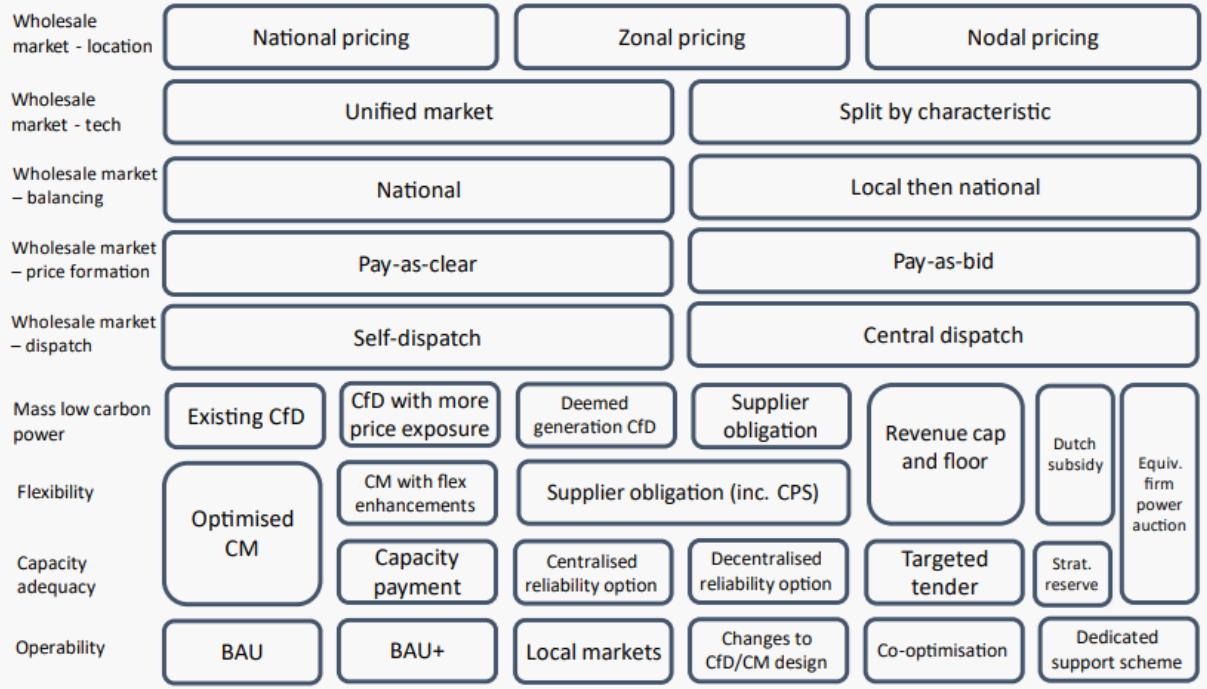
The second consultation on the Review of Electricity Market Arrangements (REMA) was published on 12th March

- The Government published its first REMA consultation in July 2022 outlining a range of options for reforms to electricity markets.
- This has been followed up by the second consultation this week that narrowed down these options.
- The aim of the REMA programme is to ensure that the electricity market is fit for purpose for the future.
- This means delivering reform that facilitate the meeting of the full decarbonisation of the electricity system by 2035 target whilst being cost-effective for both the system and consumers.
- REMA is looking at reforms across the whole electricity system including on wholesale markets, balancing mechanism, capacity market and low carbon support schemes.
- The government plan to conclude policy-development of REMA by mid-2025 and into implementation from 2025 onwards.

REMA Milestones



Summary of market reform options in REMA



Why is it needed?

Increasing decarbonisation and higher demand could create problems for the future system

Increased penetration of renewables and greater electrification are highlighting structural issues and creating opportunities for further investment and development in GB. LCP Delta's case for change which was used as the basis of the first consultation outlines the key issues:

- **Low carbon capacity** – Significant investment is needed, including firm "backup" capacity. This may necessitate changes to support mechanisms for new and existing technology.
- **System flexibility** – Balancing supply/demand will become more challenging. Periods of excess renewable generation will become longer and more commonplace
- **Locational issues** – The location of flexible assets is of high importance as system locational constraints are set to persist.
- **System operability** – Less of the system's operability requirements provided by thermal generation as renewables increase penetration
- **Price volatility and signalling** – prices will become more volatile due to fluctuations between periods of high and low renewable output.

RES Capacity may increase
3-4x
by 2035

5x more low carbon flexibility assets needed by 2035

Network constraint costs £2-3bn per year in late 2020s

Second REMA Consultation

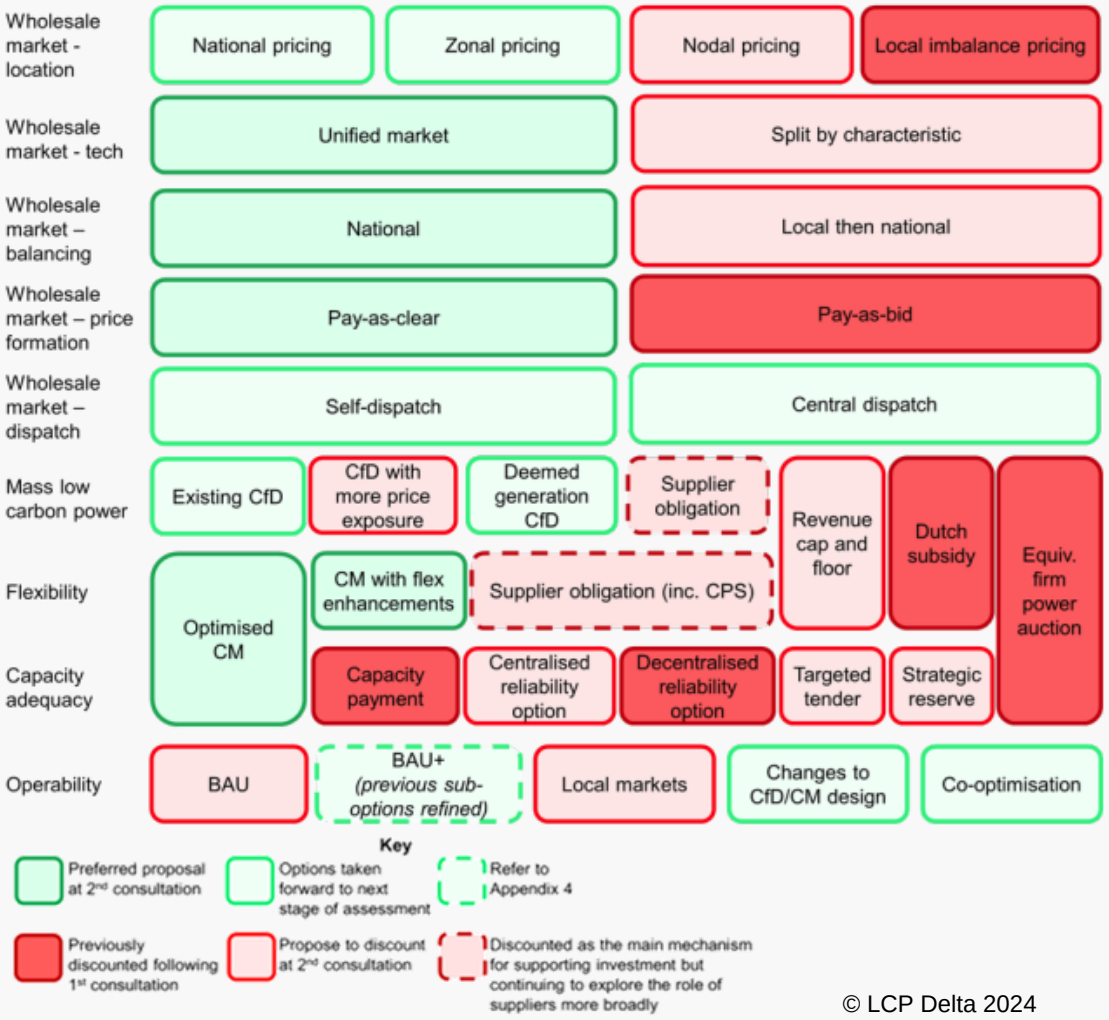
The second consultation discounted some options, but many still remain on the table

The consultation is structured around 4 challenges for the future system:

1. **Passing through the value of a renewables-based system to consumers**
2. **Investing to create a renewables-based system at pace**
3. **Transitioning away from an unabated gas-based system to a flexible, resilient, decarbonised electricity system**
4. **Operating and optimising a renewables-based system, cost effectively**

In some areas the consultation has a preferred option that the government is progressing but in others there are still multiple options being assessed

Summary of market reform options in 2nd REMA Consultation (Green = still an option, red = discounted)



Second REMA Consultation

The second consultation discounted some options, but many still remain on the table

Challenge	Reform options	Comments
Passing through the value of a renewables-based system to consumers	• Retaining marginal pricing • Cross cutting approach to Demand Reduction (DR)	• Green Power Pool and Split Market discounted for single market.. • Voluntary CfD discounted due to price lock in of aging assets. • Options to enhance DR, including market-based support such as through the Capacity Market (CM)
Investing to create a renewables-based system at pace	• Current CfD • Deemed CfD • Capacity style payment • Reforms to reference price	• Options to enhance price exposure to encourage units better lend themselves to operability. • Deemed CfD will allow for support to remain whole when curtailed for system benefit. • Capacity based support also protects against volume risk
Transitioning away from an unabated gas-based system to a flexible, resilient, decarbonised electricity system	• Retaining a CM, but optimised	• A preference for a single auction with multiple clearing prices based on technologies to increase participation and value of low carbon assets. • Minimum target for certain technologies that the Government 'wants' to procure' (e.g. flex)
Operating and optimising a renewables-based system, cost effectively	• Reducing Settlement Period duration • Zonal pricing to be further considered after nodal rejected • National pricing with reform	• Reducing SP to 15 or 5 mins explored to maximise flexibility. • Locational price signals are still deemed important. However, Government acknowledges that this could be achieved by maintaining a national price market but with reform of the access, charging and BM.

LCP Delta insights: How REMA may impact assets

REMA will have significant impact on current and future investments

Offshore wind

- Increased locational signals (zonal or other) could **move more investment in capacity** in Southern England closer to demand centres.
- **Choice of reference price in the CfD** under zonal pricing could expose plants to more risk.
- **CfD will remain broadly similar** – have excluded green power pool and a split market that would have been bigger changes.
- Options for deemed or capacity based CfD which reward for potential to generate. Could mean **offshore wind participating in other markets** changing the way in which they operate
- Scope of CfD includes support to **repower existing projects**.
- Government interested **in role of Corporate PPA's** and whether CfD's cover only part payment. Could also support "Merchant Tail"

Low carbon thermal

- Increased **locational signals could reduce generation of these assets** as renewables located closer to demand.
- Revenues obtained through constraint payments under national pricing likely to be lower than wholesale market payments under zonal pricing.
- **Capacity Market remains primary market** for valuing capacity and main source of revenue for these technologies.
- **'Optimised CM**' would lead to differing CM clearing prices for low carbon assets meaning **higher clearing prices for these assets** where auction competition is low.
- "Transitioning away from bespoke support" – could impact development of H2 and CCUS projects. Expectation that Optimised CM delivers required support.
- Acknowledging role of unabated gas and need to transition **allows build of 'decarbonisation ready' H2 and CCS plants**

Storage

- Continuing role of marginal pricing ensures there will be price spreads for storage
- **Zonal pricing could lead limited price arbitrage opportunity in Scotland** / congested areas – so value moves South
- **Market opportunity** – stated expectation that GB electricity system could require up to 55GW of short-duration flexibility and between 30 and 50GW of long-duration flexibility
- An **optimised CM may impact clearing prices** for batteries where batteries will set a clearing price
- Commitment to **continue to develop cap and floor for LDES** to mitigate emerging technology risk

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Deep dive: Locational Pricing

What is locational pricing?

Different prices across the country rather than one national price

National Pricing (current arrangements)

Single ***national wholesale price*** with re-dispatch in the balancing mechanism to resolve constraint issues.

Locational signals given through LRMC of investment at a specific point on the network charged through ***TNUoS regime***

Separate charge for locational losses.

Currently used in:

GB

Germany

Zonal pricing

Prices reflect marginal cost of generation, ***accounting for congestion on zonal boundaries***.

Illustrative GB zone boundaries

Locational ***signal embedded within zonal prices***, but potential need for TNUoS type signal within larger zones.

Currently used in:

Italy

Denmark

Norway

Nodal pricing

Prices reflect the marginal cost of generation at each node taking into account congestion and losses

Illustrative GB price nodes

Locational ***signal embedded in the price*** reflecting the short-run marginal costs of congestion.

Currently used in:

New Zealand

USA (various states)

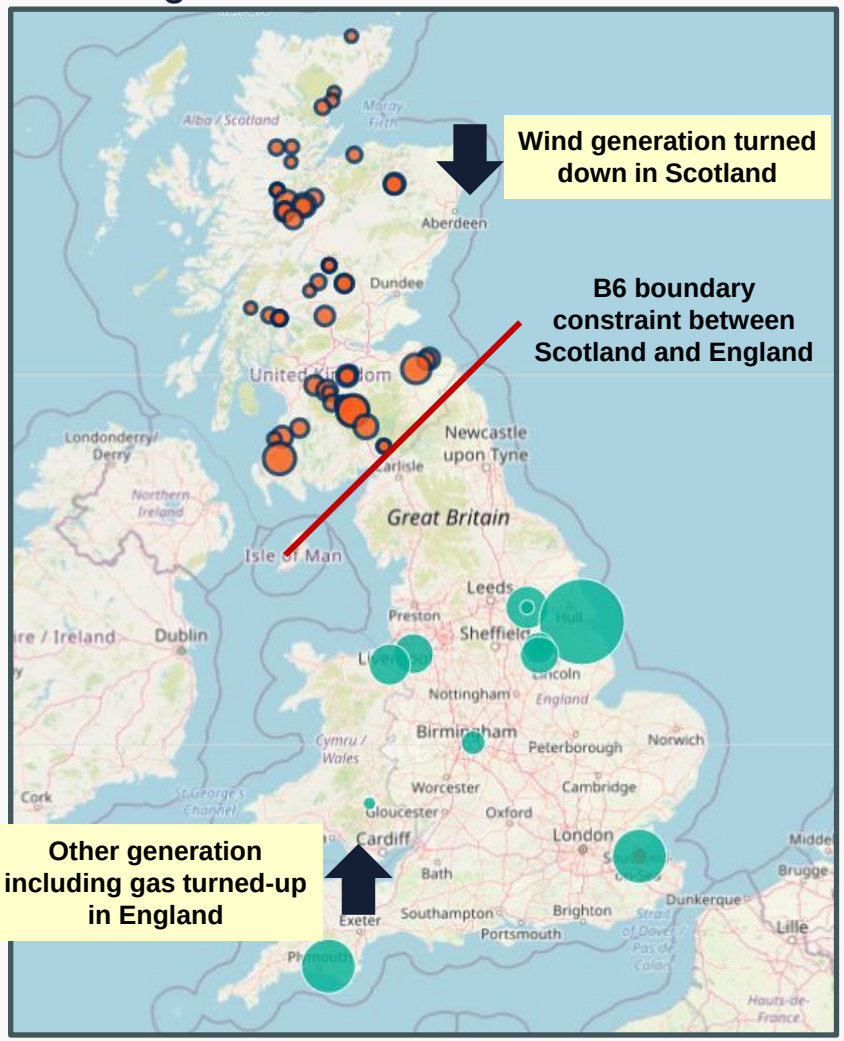
Canada (Ontario)

Why do we need better locational signals?

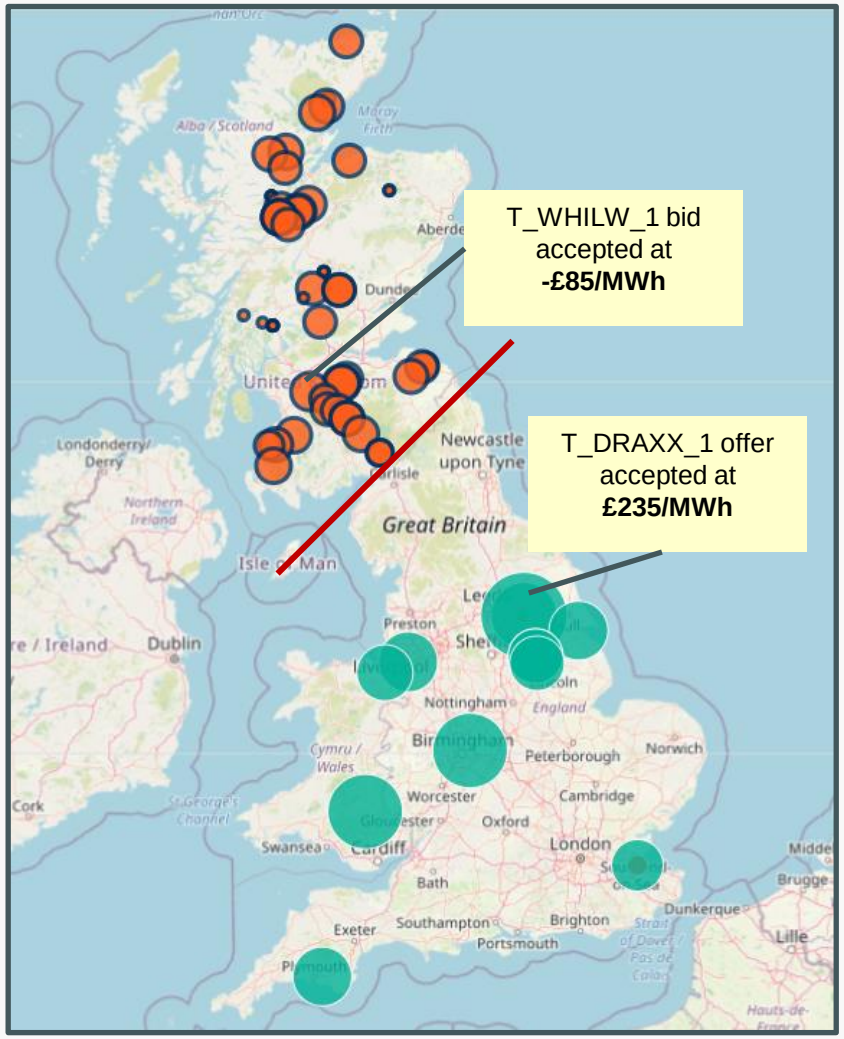
January 2nd 2022 may be more typical of what we see in the future

- In this example day, the price for this settlement period was £154/MWh.
- The B6 boundary network constraint between Scotland and England stops wind generation in Scotland transporting to meet demand England.
- As a result, ESO has to turn-down wind in Scotland and turn-up generators (mostly gas) in England.
- Better locational signals could mean assets locate closer to demand.

Balancing volumes



Balancing System Action prices

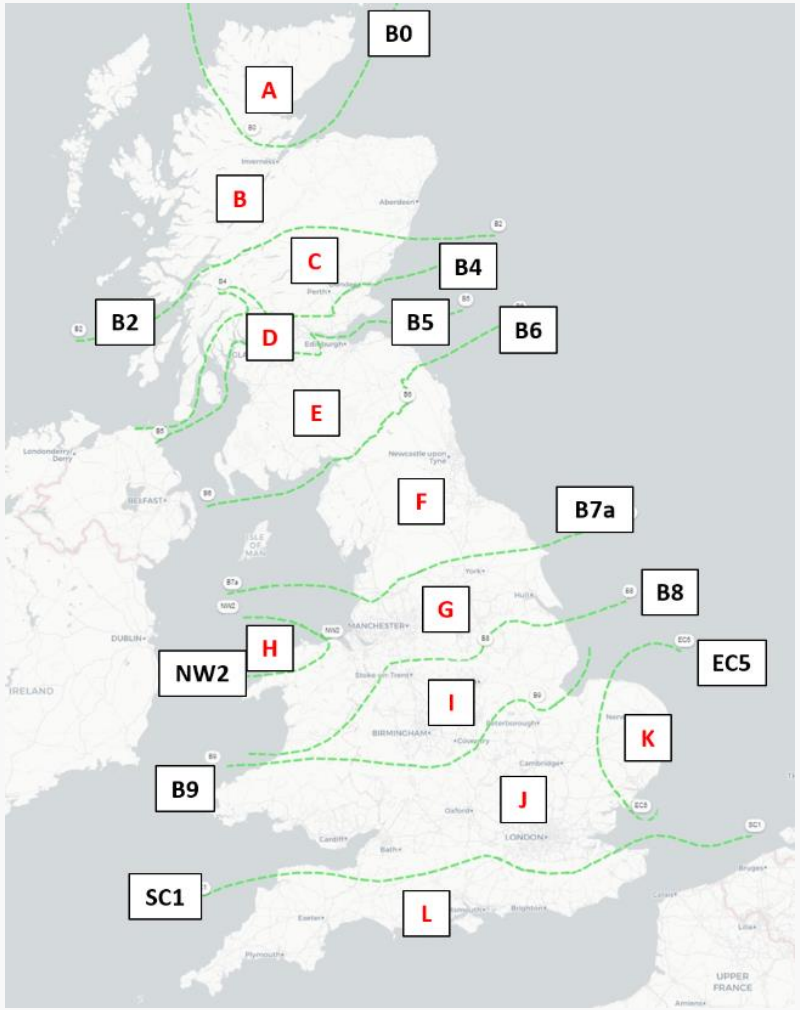


LCP Delta Study on Locational Pricing

Our ‘System Benefits from Efficient Locational Signals’ was published alongside the REMA Consultation

- LCP Delta and Grant Thornton were commissioned by Government to assess the impacts of alternative locational investment and operational signals within the electricity system by modelling the market under locational pricing.
- The impacts on the system and consumer costs in the electricity system were assessed, based on a move from the current national pricing model (counterfactual) to a locational pricing model (factual).
- The assessment was completed under a number of different scenarios that looked at some of the key uncertainties including impact on investment, network delays and interaction with other government policies
- The study utilises LCP Delta’s Locational Dispatch Model (LDM) which enables detailed modelling of locational constraints on the network.
- For this analysis, a zonal approach where the country is split into 12 zones which capture the key transmission network boundaries is used.
- The full report can be found here.

Zones used in LCP Delta Locational Pricing Study

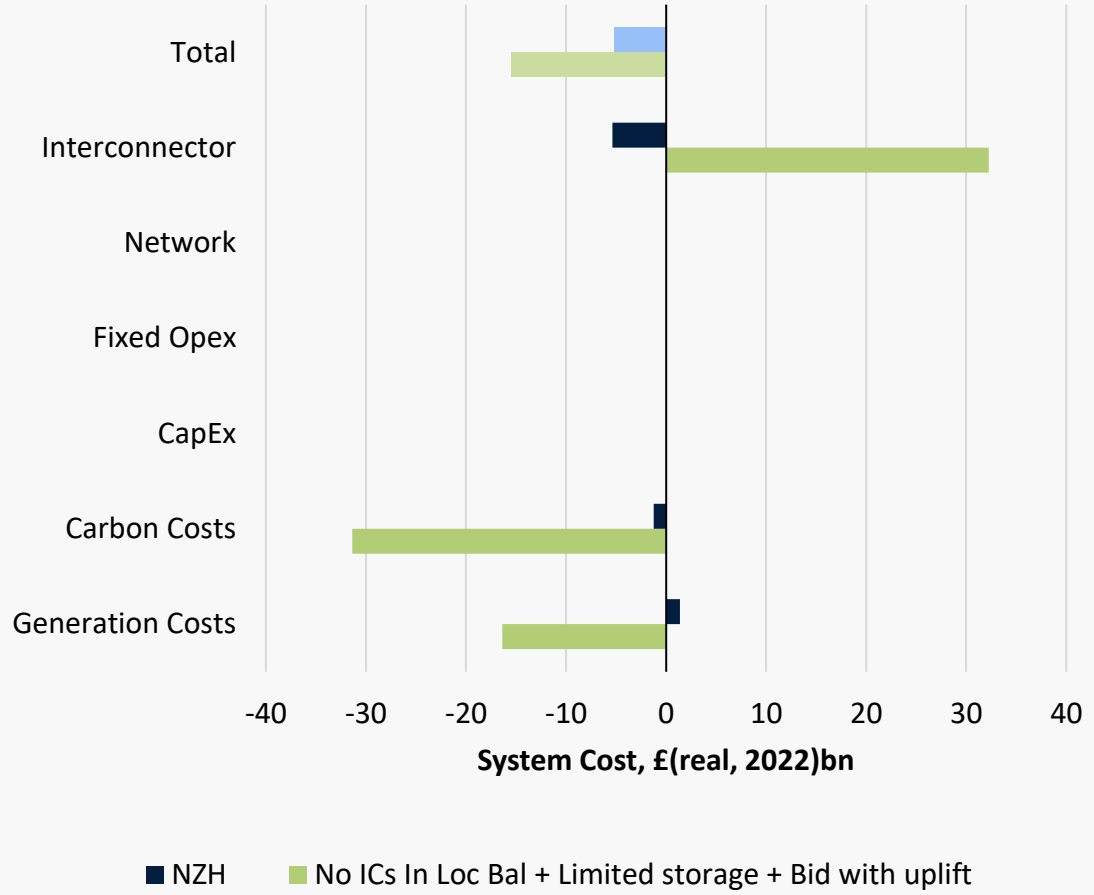


System Impacts

With no assumed impact on cost of capital, moving to locational pricing can bring benefits of £5-15bn

- In scenarios based on DESNZ's Net Zero higher demand scenario and with no assumed impact on cost of capital, moving to locational pricing decreases 2030 to 2050 electricity system costs by £5-15bn (NPV in 2022 real prices).
- The drivers of these benefits are split into two types:
  - **Investment efficiency**, where more efficient locational signals cause plants to locate in areas more beneficial to the system. For example, more renewables locating closer to demand centres.
  - **Operational efficiency**, where cost savings are a result of changes in the operation of the market (regardless of plants changing location). This is mainly around changes to how interconnectors and storage operate to balance constraints.
- The benefits of moving to locational pricing are subject to various uncertainties around the future make-up of the power sector and how locational pricing is implemented. Many of these are tested in the analysis undertaken.

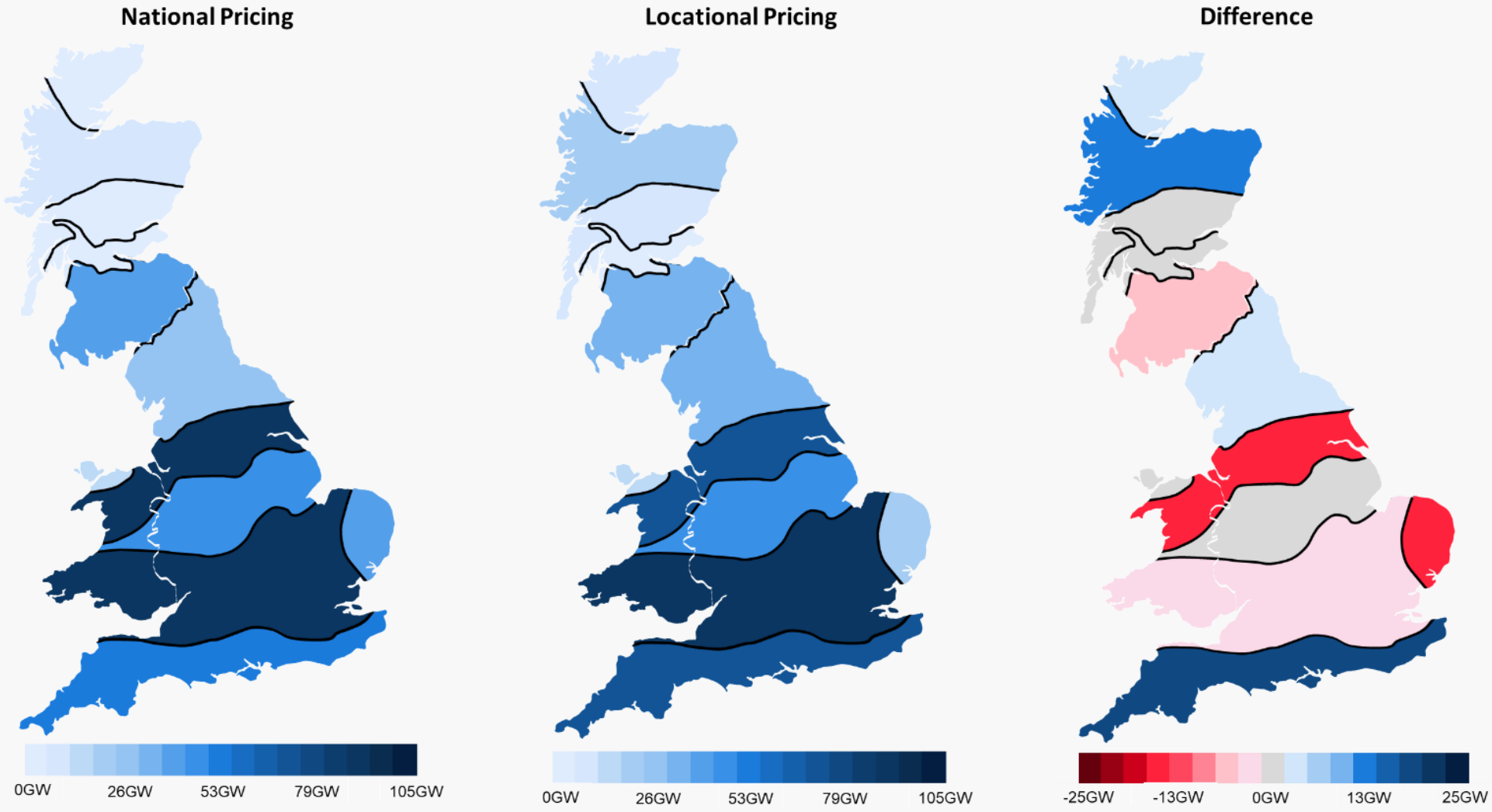
Overall system cost change of moving to locational pricing in core scenario (NZH) and redispatch inefficiency scenario



Impacts on Capacity

The changing locational signal of locational pricing leads to capacity locating in locations that are more beneficial to the system

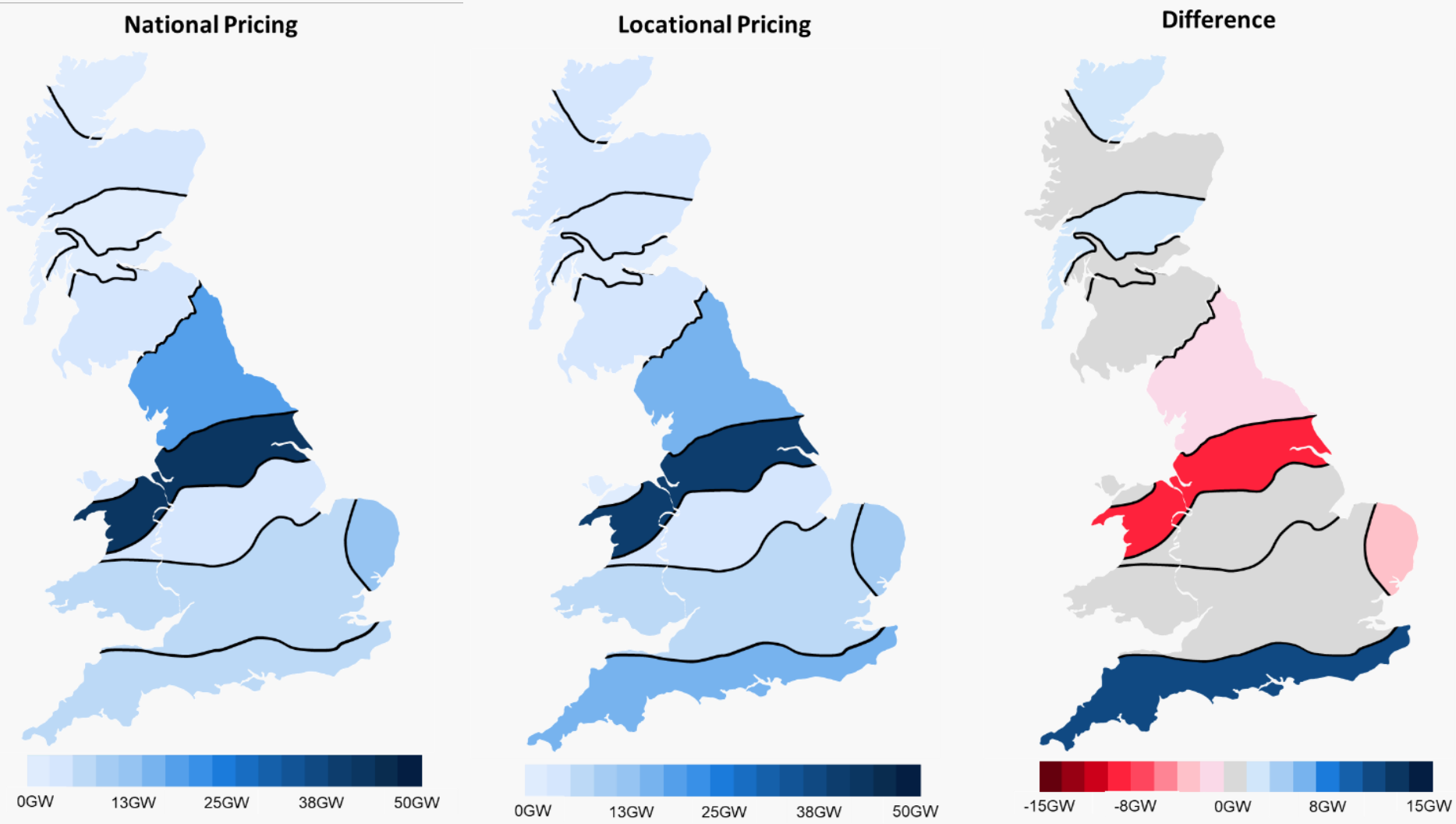
- Differences in location of capacity as a result of locational pricing is the key benefit.
- More renewables locate closer to demand centres in the south with other technologies moving further north.



Impacts on Capacity – Offshore Wind

Locational pricing leads to more offshore wind locating in Southern England

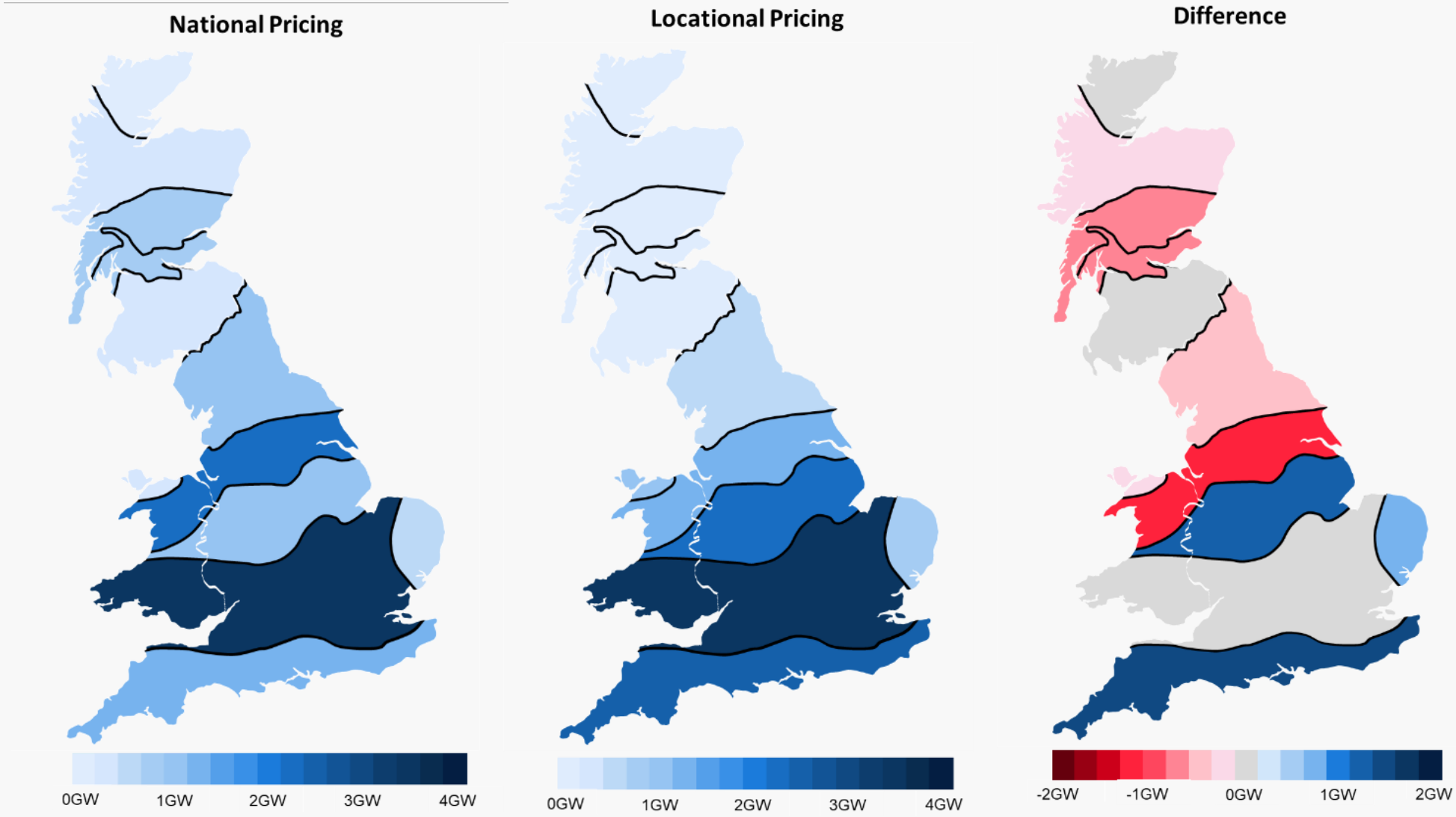
- Under national pricing, most offshore wind build locates in North England and East Anglia where higher load factors without high TNUoS charges.
- Under locational pricing, less capacity locates in these areas with more capacity in Southern England closer to demand centres and below the SC1 constraint.



Impacts on Capacity – Batteries

The changing locational signal of locational pricing leads to capacity locating in locations that are more beneficial to the system

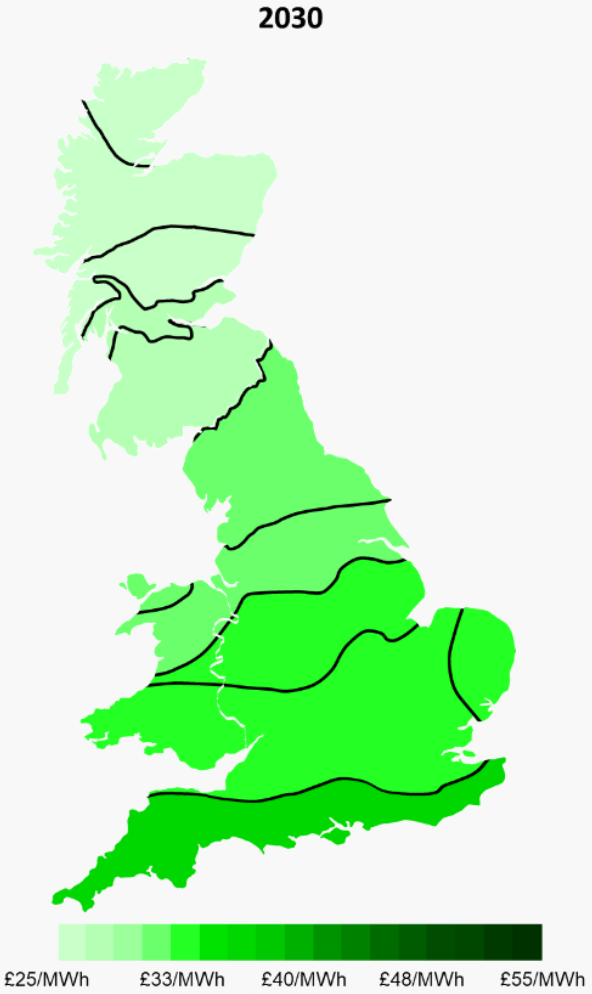
- Under national pricing, most batteries locate in across England and Wales with a few in Scotland.
- Under locational pricing, capacity concentrates in southern areas moving away from Scotland and Northern England.
- This reflects movements to where price spreads are highest.



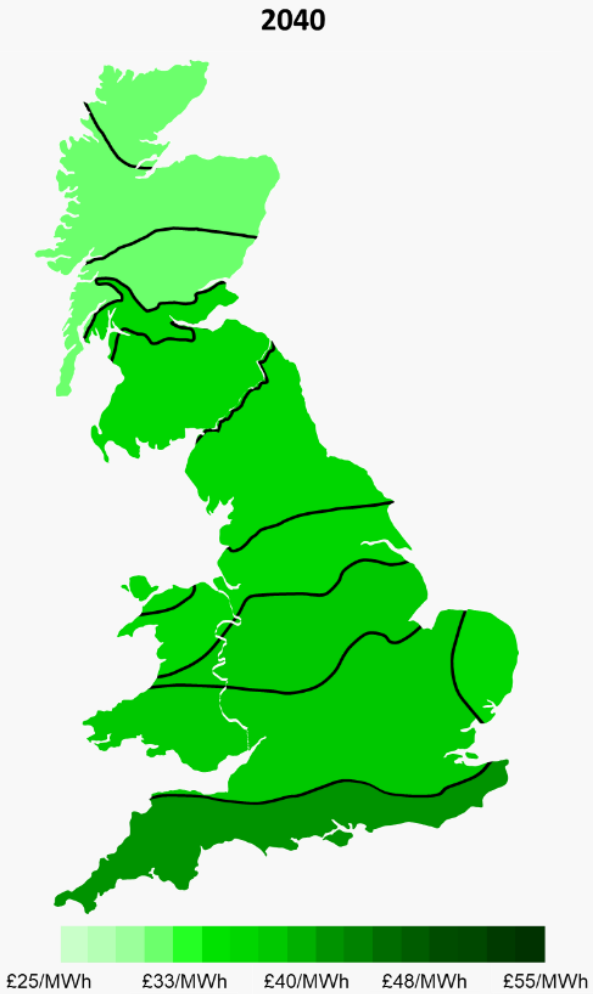
Wholesale Prices

Wholesale Prices now vary across the country with lower prices in Scotland and higher prices in England

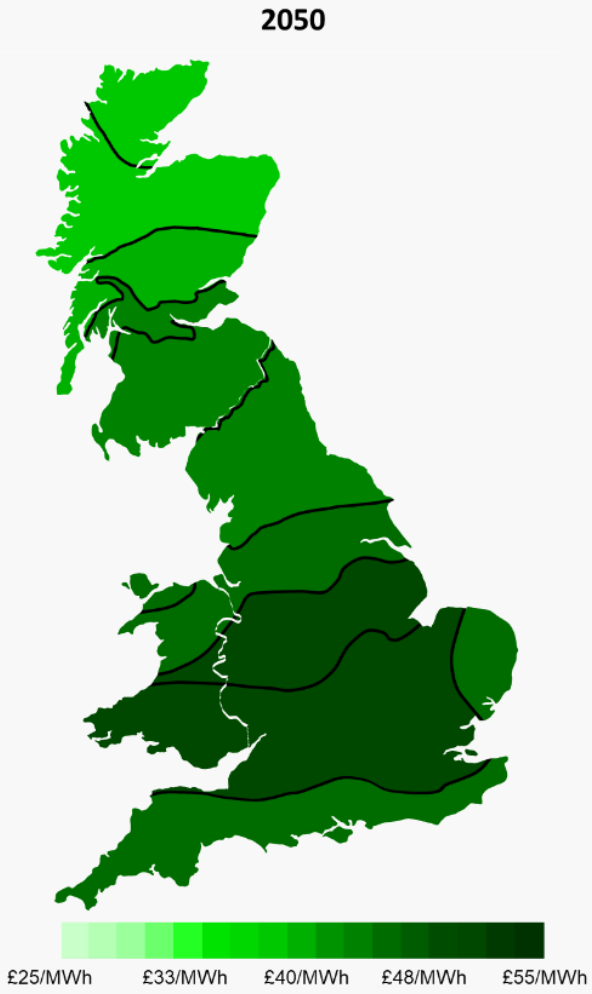
- Under locational pricing, prices vary across the country with the lowest prices in Scotland and highest in south of England.
- The price reflects the type of capacity located in each zone and the demand level.
- On average, prices are slightly higher in locational pricing as cost of constraints are reflected in the price.
- Given the disparity across zones, it will be important for policy makers to consider whether end users in different zones should pay different prices for their energy.



National price: £31/MWh
Locational Price: £25-37/MWh



National price: £36/MWh
Locational Price: £30-43/MWh



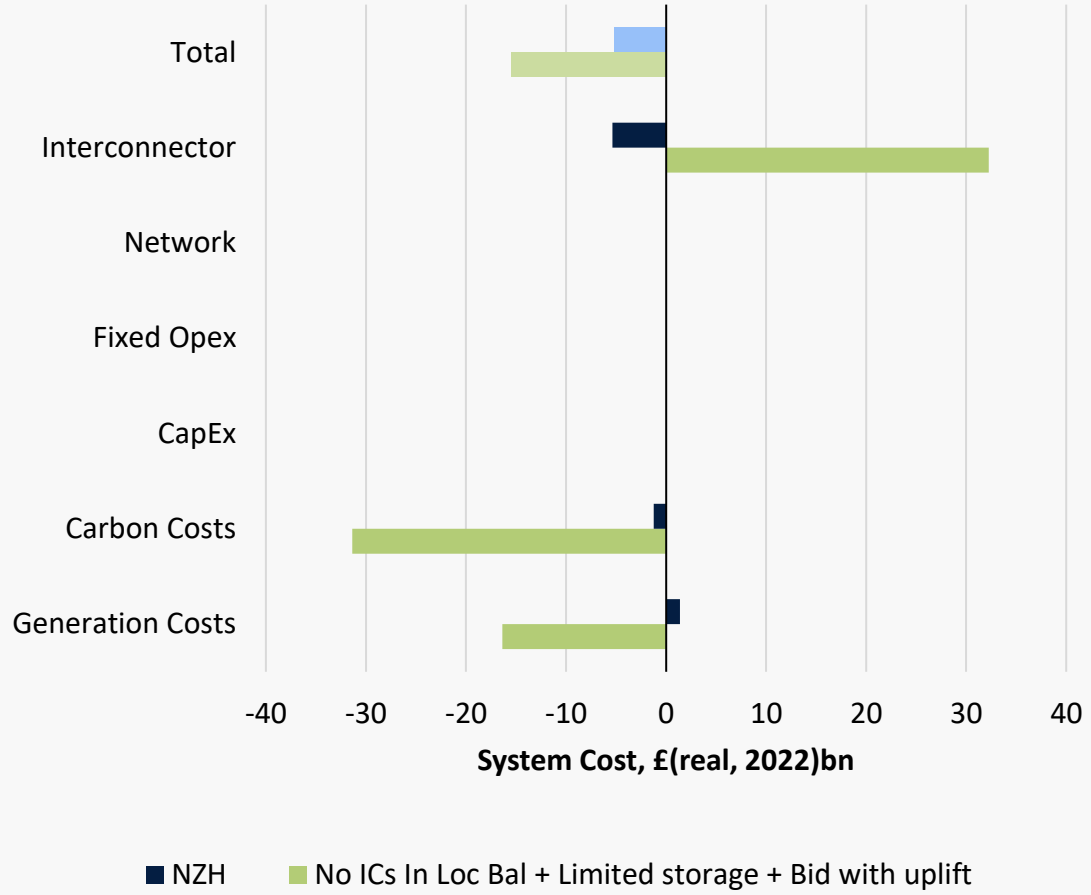
National price: £43/MWh
Locational Price: £38-51/MWh

Operational Impacts

If changes can be made to interconnector redispatch under national pricing, this limits the impact of moving to locational pricing

- What is assumed in the national pricing counterfactual, particularly on how interconnectors flow with the respect to constraints, make a key difference to the results.
- Under existing redispatch in our national market, interconnectors can often exacerbate constraint issues as they are limited in how they in their participation with intraday and balancing markets.
- Moving to locational pricing would eliminate this issue as interconnectors are responding to the locational price at day-ahead stage giving an 'operational efficiency' benefit.
- However, these benefits are not necessarily unique to locational pricing and could be achieved by reforms to our national pricing model (although more research is needed on this). As such we have tested a scenario where these redispatch inefficiencies are removed in the national pricing counterfactual.
- System benefits of moving to locational pricing are £5bn with redispatch inefficiencies in the national pricing counterfactual assumed to be removed/minimised and £15bn where redispatch inefficiencies are assumed in the national pricing counterfactual.

Overall system cost change of moving to locational pricing in core scenario (NZH) and redispatch inefficiency scenario

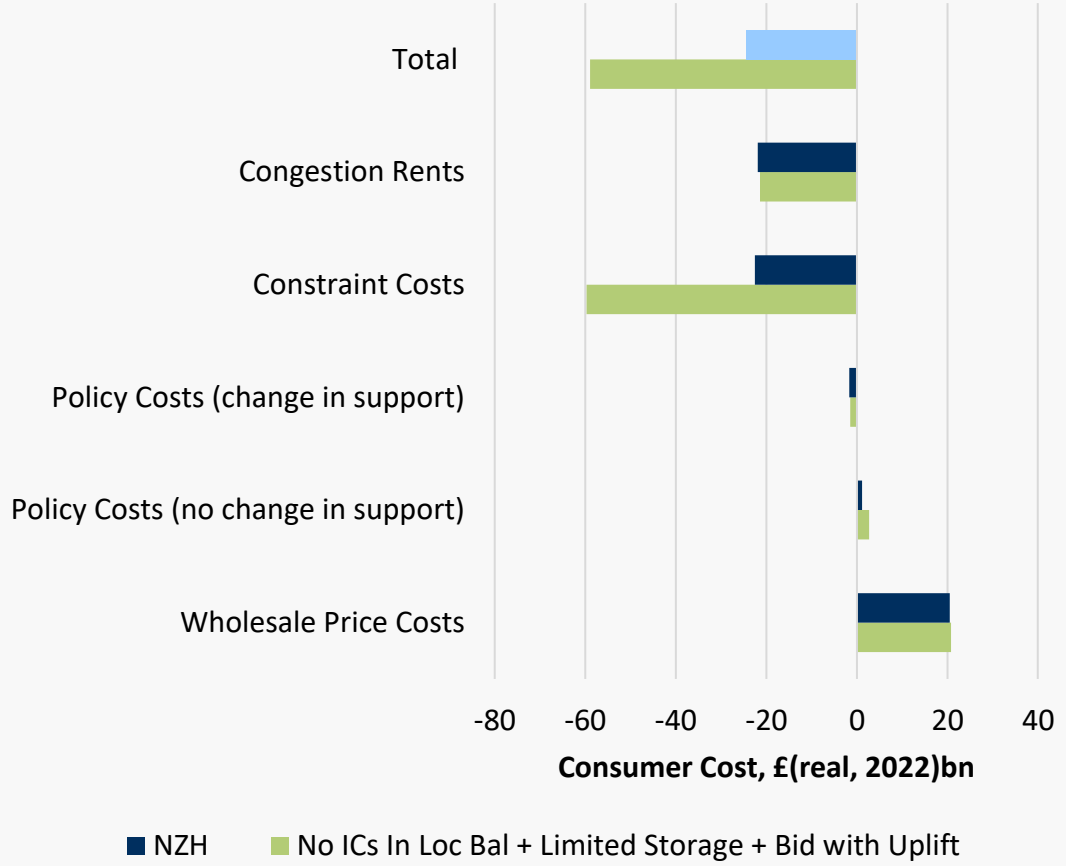


Transfers from Consumers to Producers

A move to locational pricing has higher benefits for consumers but increasing costs for producers

- Our analysis shows that moving to locational pricing will see large transfers between producers and consumers, with consumers benefiting greatly.
- Moving to locational pricing sees consumer benefit by £24-59bn but this results in producer costs increasing by £19-36bn.
- Transfers from consumers to producers are higher with redispatch inefficiencies assumed in the national pricing counterfactual.
- While wholesale prices increases slightly, the constraint payments previously given to generators under national pricing no longer exist while consumers also benefits from the introduction of congestion rents across zone boundaries in locational pricing.
- These transfers of costs could create additional risks with the power sector that need to be mitigated by government, for example additional support to ensure new low carbon capacity builds.
- In our analysis, it is assumed that consumers are not themselves are not exposed to locational pricing.

Overall system cost change of moving to locational pricing in core scenario (NZH) and redispatch inefficiency scenario

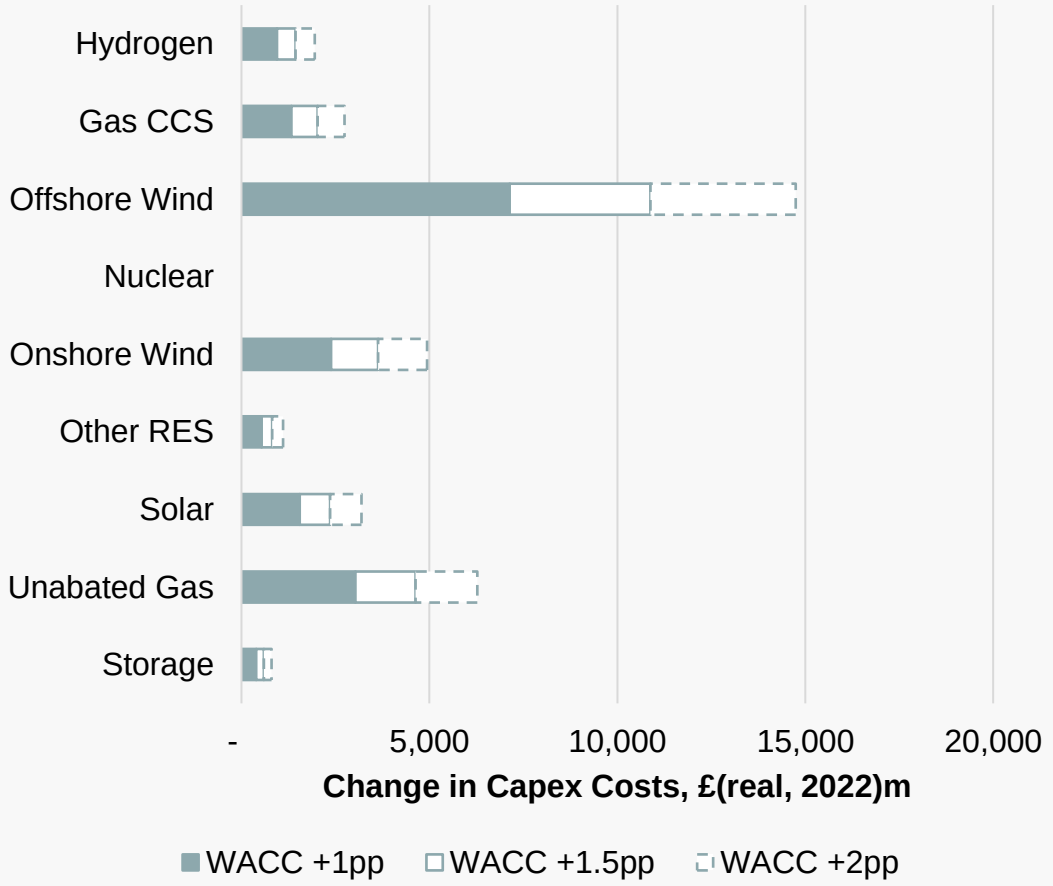


Cost of Capital Impacts

Increases to cost of capital for building new capacity could wipe out system benefits

- The cost of capital is the expected compensation required by investors to undertake risky investments. The higher the uncertainty around future cash flows, the higher the risk for an investor.
- The complexity and uncertainty around the introduction of locational pricing could mean that investors see GB power investments as riskier leading them to require a higher WACC.
- There is significant uncertainty as to whether introducing locational pricing would increase cost of capital for investors, and if so, to what extent. As such we tested a range of impacts.
- Our analysis finds that system cost benefits could be outweighed by modest increases in the cost of capital. Uniform increases of 0.3 to 0.9 pp in cost of capital for all technologies (excluding Nuclear) results in a move to locational pricing becoming a net cost to the system.
- A 1pp increase results in a move to locational pricing becoming a net system cost of £4-12bn and a 2pp increase a net system cost of £23-30bn.
- It is possible that increases in risk and cost of capital could also lead to a reduction or delays to investment. This was considered out of scope of the study.

Changes in Capex Costs (NPV) in the DESNZ Net Zero higher scenario for various levels of WACC percentage point increase.

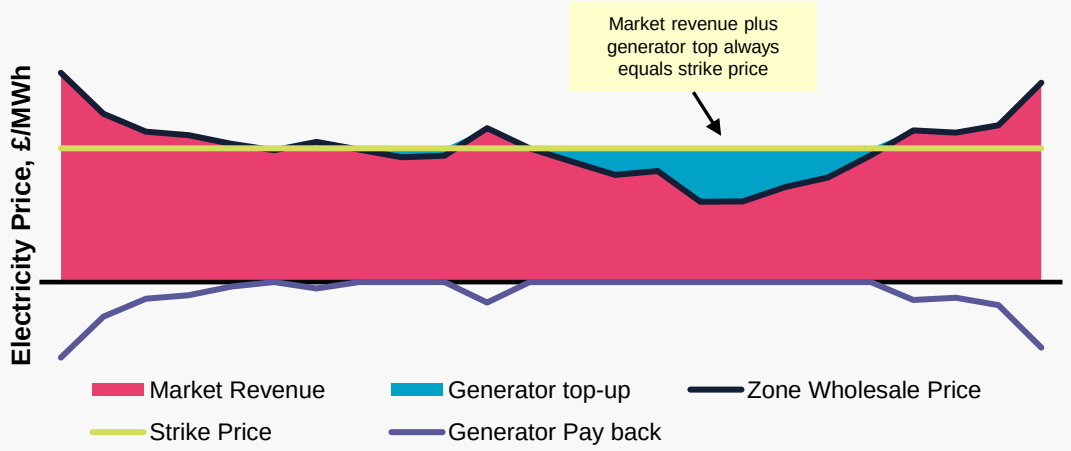


Interaction with the CfD

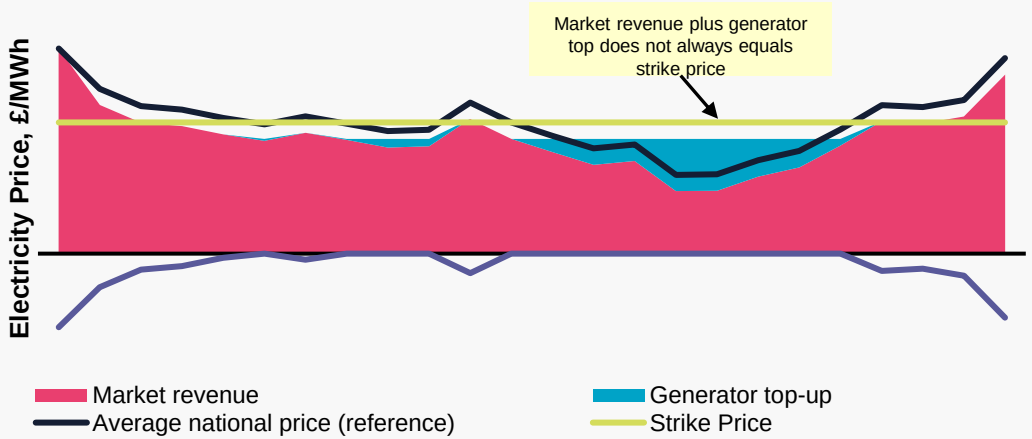
How the CfD scheme interacts with locational pricing is important for government and investors to consider

- The level of exposure new CfD plants would have to locational pricing would depend on the what the reference price is:
  - A **zonal reference price** would limit a CfD plant's exposure to locational pricing as when generating they would always receive their strike price. Locational exposure is limited to the risks associated with curtailment ("volume risk").
  - A **national reference price** would fully expose CfD plants to locational pricing. In zones where the zonal wholesale price is less than the national reference price, top-ups may not be enough for CfD plants to obtain the full strike price.
- The advantage of the national reference price is that CfD plants are more likely to locate in areas which are for beneficial to the system.
- Our analysis shows that the system benefits of locational £3.5bn higher if national reference price is used over zonal price
- However, this approach exposes CfD plants to more risk which could undermine the principles of the CfD regime and reduce investability in these plants.

Example of CfD under zonal reference price (less exposure)



Example of CfD under national reference price (more exposure)

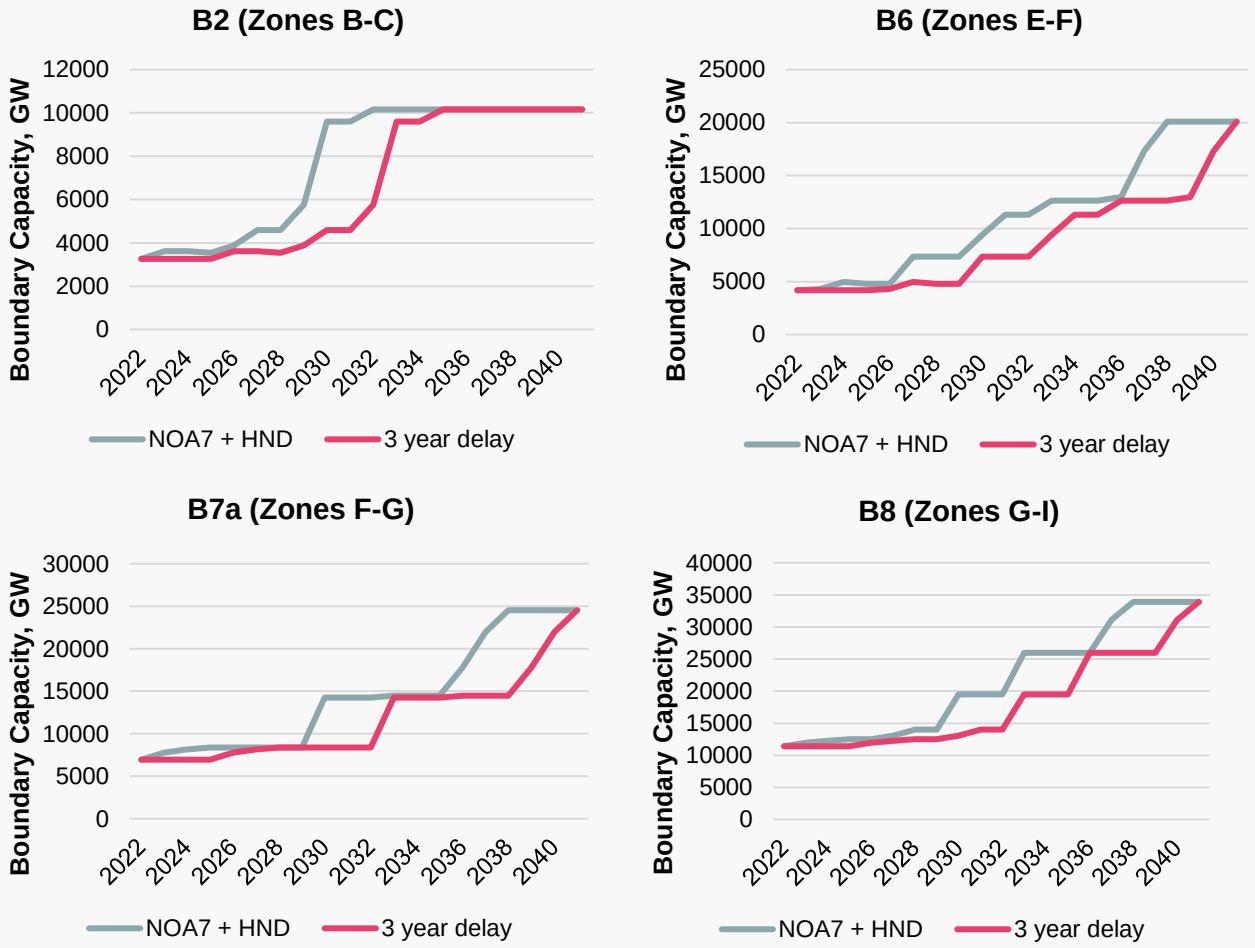


Impacts of Network Delay

Delays to assumed network build could increase the system benefits

- Future network reinforcement levels are a vital assumption for assessing the impact of moving to location pricing.
- This is because plants moving to locations that are closer to demand centres to avoid network constraints is one of the key potential benefits of locational pricing.
- A more constrained network will lead to higher benefits from moving to locational pricing as plants moving location has more of an impact.
- National Grid ESO's NOA7 refresh outlines plans to increase network capacity across key boundaries by up to 5x by 2040.
- The study finds that a delay in network build can increase the benefits of moving to locational pricing with a 3-year delay in the NOA7 refresh network build increasing benefits of moving to locational pricing by 10% (2030-50).

Projected network capacity at selected boundaries



Conclusions

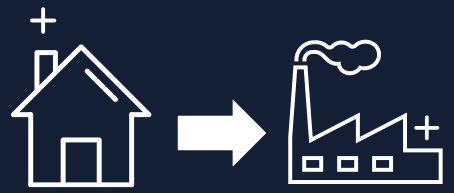
The implementation of locational Pricing brings benefits to the GB energy system, but benefits may be offset by associated risks

Moving to locational pricing can bring benefits to the GB energy system

Our analysis shows that moving GB to a zonal pricing model can brining system benefits of £5-15bn under the DESNZ Net Zero Higher Demand Scenario.

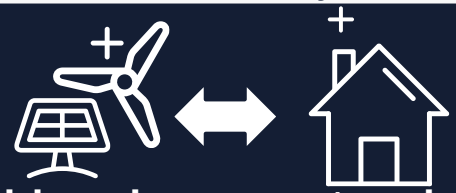
Assumptions on redispatch in the national pricing counterfactual are key

Our analysis shows system benefits are reduced from £15bn to £5bn with a more efficient redispatch of Interconnection assumed in a national pricing model.



Locational pricing leads to a transfer of costs from consumers to producers

Our analysis shows that a move to locational pricing could benefit consumers by £24-59bn, but this results in producer costs increasing by £19-36bn.



Benefits are driven by generators locating closer to demand centres

The more efficient locational signal that locational pricing provides compared to existing TNUoS arrangements leads to capacity locating in areas more beneficial to the system.

Increases to cost of capital could wipe out the system benefits

Our analysis shows that if locational pricing leads to increases of 0.3 to 0.9 pp in the cost of capital for all technologies (exc Nuclear), system benefits are reduced to zero.

Delays to assumed network build could increase the system benefits

Our analysis shows that if there is a 3-year delay to the planned network build, this would increase the benefits of moving to locational pricing by 10%.

LCPDelta

Who we are

Introducing LCP

- We are a financial services and analytics consultancy with offices in London, Winchester, Edinburgh, Cambridge, Dublin and Paris
- We are a partnership, founded in 1947.
- We offer independent modelling, software and advice across pensions, investment, insurance, energy and health.
- LCP Delta is our specialist energy practice, formed through the merger of LCP Energy and Delta-EE

~ 1000 experts

6 offices

700+ clients

Advising 45% of the FTSE100

Introducing LCP Delta

Powering the energy transition across the whole value chain

LCP Delta is a specialised energy transition practice providing

- Subscription research
- Consulting
- Data and analytics
- Training

…to clients that are active in all parts of the value chain

- Generation & storage
- Networks
- Demand

…delivering expertise and advice in

- Power market forecasting
- Energy storage & flexibility
- Hydrogen
- Power trading
- Distributed power
- Policy impact analysis
- System modelling
- Business models
- EV charging infrastructure
- Connected home & HEM
- Low carbon heat
- Customer decision making
- Community energy

~ 100 people

Active since 2004

200+ clients

Our services in power market forecasting and due diligence

In-depth forecasting and analysis for the GB and Irish markets

"We've worked closely with LCP for almost a decade, and they've provided us with market-leading analysis and modelling tools to support key commercial decisions.

They get to grips with the most significant issues and invariably deliver significant insights"

Mark Jones, UK market analysis manager - RWE

- **Revenue forecasts** for the lifetime of assets in GB and Ireland across the stack. We cover the full suite of technologies, including **battery storage, wind, solar, CCGT, hydrogen, peakers, CCUS and nuclear.**
- **Scenario analysis** including FES/internal/external scenarios and 'low' and 'high' for each asset type.
- **Market evolution forecasts** including generation mix, carbon emissions, prices across different markets, renewable penetration and interconnection of markets.
- **Network charging forecasts** including TNUoS, TLM and GDUoS forecasts.
- **Locational impacts** including impacts of curtailment, imbalance risk and correlations across portfolios.
- **Policy impact analysis** from a quantitative and qualitative perspective.
- **Economic, policy and regulatory reports** detailing the impact of the changing landscapes on individual assets.
- **Strategic analysis** including portfolio-wide approaches.

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About LCP Delta

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